DATE November 1, 2019

No. V-8474-E

Messrs.

SPECIFICATION

Oxygen Sensor Module
Low Oxygen Range

Model: FCX-MP-F-AC: 50 to 1000ppm O_2
FCX-MQ-F-AC: 0.05 to 1% O_2

Project:

Distributor: Distributed by:
Servoflo Corporation
75 Allen Street
Lexington, MA 02421
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Reference:

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Table of Contents

Table shown below is revision records of this specification

3				
2				
1				
Est.	Nov. 1, 2019	Y. Uchiumi	Refresh	
	Date	Name	Comment	Mark

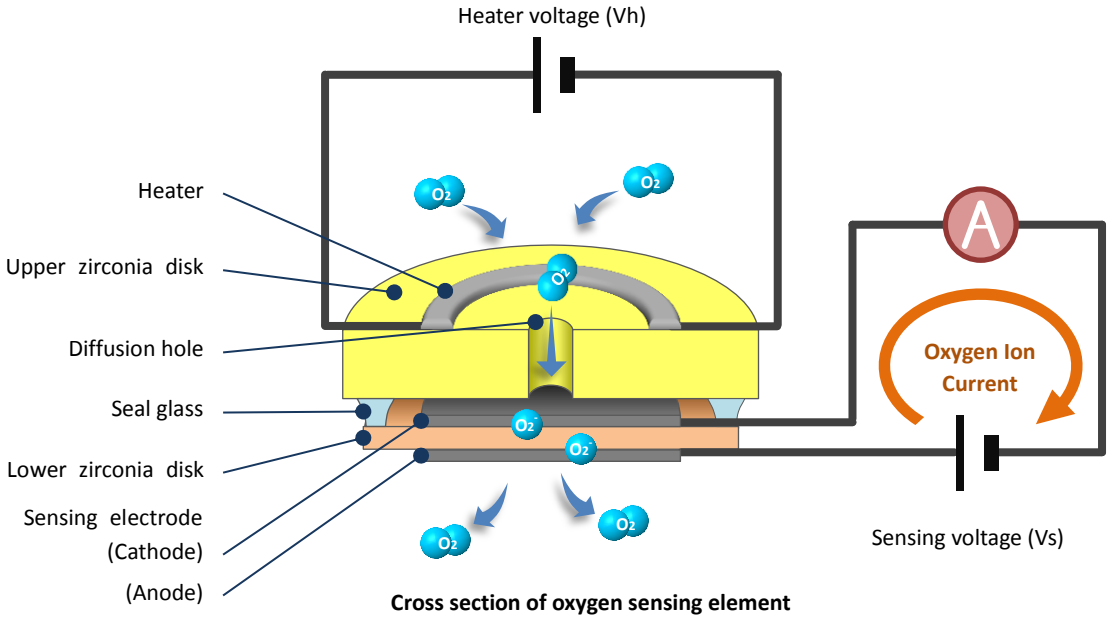
1 General

This document describes about the specification of Fujikura Ceramic Oxygen Sensor modules FCX-MP-F-AC and FCX-MQ-F-AC.

2 Principle of Fujikura Oxygen Sensor Element

Fujikura oxygen sensor is based on **limiting current method using zirconia solid-electrolyte** that has oxygen ion conductivity at high temperature. The upper side zirconia disk has a heater and a diffusion hole. A pair of electrodes is printed on the both side of the lower side zirconia disk. Two zirconia disks are bonded together by sealing glass and there is a cavity between the upper side zirconia disk and the lower side zirconia disk.

Sensing voltage is applied to the electrodes on the lower side disk and heater voltage is applied to the heater on the upper side zirconia disk. Oxygen ion conductivity is generated at the lower side disk when the oxygen sensing element is heated up to about 450°C. Oxygen in the cavity is converted to oxygen ions on the cathode electrode, moved to the anode electrode by the sensing voltage. Oxygen ions are converted to oxygen once again. There is no oxygen in the cavity when oxygen is pumped out. Oxygen at the outside flows into the cavity through the diffusion hole. However, oxygen flow is limited by the diffusion hole, oxygen ion current appears constant. Oxygen density can read from this behavior.



Cross section of oxygen sensing element

3 RoHS

This product is compliant with the Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS).

4 Device Name Code

FCX	-	MP	-	F	-	AC

Sensor housing:	**AC:**	Sensor housing equipped
RoHS:	**F:**	RoHS compliant
Model:	**MP:**	50 to 1000ppm O_2
	MQ:	0.05 to 1% O_2
Series:	**FCX:**	Fujikura Ceramic Oxygen Sensor

5 General Specifications

Item	Condition		Rating Min.	Rating Typ.	Rating Max.	Unit	
Measuring Gas			Oxygen				*1
Gas Sampling			Input to sensor housing				
Measurement Range	FCX-MP-F-AC		50	-	1000	ppm O_2	*2
	FCX-MQ-F-AC		0.05	-	1	% O_2	
Accuracy	FCX-MP-F-AC		-50	-	+50	ppm O_2	
	FCX-MQ-F-AC		-0.05	-	+0.05	% O_2	
Output	FCX-MP-F-AC Output = -999.5 x 1000 x ln(1 - [ppmO_2]/10^6)	at 50ppm O_2	0	50	100	mV	*3
		at 1000ppm O_2	950	1000	1050		
	FCX-MQ-F-AC Output = -99.5 x 1000 x ln(1 - [%O_2]/100)	at 0.05% O_2	0	50	100	mV	
		at 1% O_2	950	1000	1050		
Power Supply			4.8	5.0	5.2	V	
Power Consumption	at 5 V		-	5	-	W	
Response Time	90%		-	-	30	sec.	*4
Warm up Time			-	5	-	min.	*5
Gas Flow Rate			200	-	1000	cc/min.	*6
Gas Pressure			-	-	500	kPa	
Operating Temperature			-10	-	50	°C	
Operating Humidity	Non condensing		0	-	85	%RH	

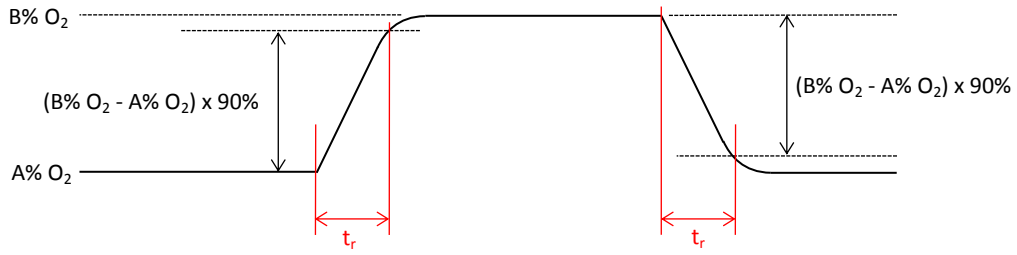
Notes:

*1) Balance gas of oxygen should be nitrogen. This module is calibrated with N_2/O_2 mixture gas.

*2) If the oxygen sensor module worked in out of the measurement range, the lifetime must be shortened.

*3) Please refer to Chapter 6 Output.

*4) Response Time (t_r)is defined as the time reaching 90% of the difference between A% O_2 and B% O_2 from the gas change started.



*5) During warm-up, the output is not correct. Please read the output once warm-up has been finished.

*6) If the pressure to the oxygen sensor changed, the output is subject to change upward/downward momentary.

6 Output

The output voltage is given by the following equation :

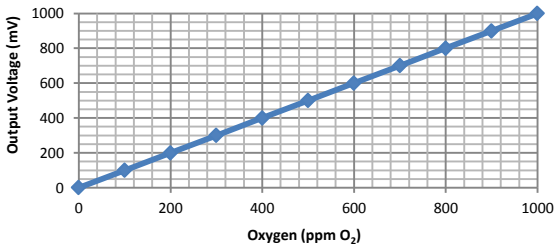
FCX-MP-F-AC **Output (mV) = -999.5 x 1000 x Ln** $\left(1 - \frac{\text{ppm } O_2}{10^6}\right)$ $\longleftrightarrow$ **ppm O_2 = (1 - exp** $\left(\frac{\text{Output (mV)}}{-999.5 \times 1000}\right)$ **) x 10^6**

Example: 7 60 ppm O_2 = 759.9 mV

Simplified Chart for Output:

Unit: mV

Hundreds part \ Tens part	0	10	20	30	40	50	60	70	80	90
0	(0.0)	(10.0)	(20.0)	(30.0)	40.0	50.0	60.0	70.0	80.0	90.0
100	100.0	110.0	119.9	129.9	139.9	149.9	159.9	169.9	179.9	189.9
200	199.9	209.9	219.9	229.9	239.9	249.9	259.9	269.9	279.9	289.9
300	299.9	309.9	319.9	329.9	339.9	349.9	359.9	369.9	379.9	389.9
400	399.9	409.9	419.9	429.9	439.9	449.9	459.9	469.9	479.9	489.9
500	499.9	509.9	519.9	529.9	539.9	549.9	559.9	569.9	579.9	589.9
600	599.9	609.9	619.9	629.9	639.9	649.9	659.9	669.9	679.9	689.9
700	699.9	709.9	719.9	729.9	739.9	749.9	759.9	769.9	779.9	789.9
800	799.9	809.9	819.9	829.9	839.9	849.9	859.9	869.9	879.9	890.0
900	900.0	910.0	920.0	930.0	940.0	950.0	960.0	970.0	980.0	990.0
1000	1000.0	–	–	–	–	–	–	–	–	–



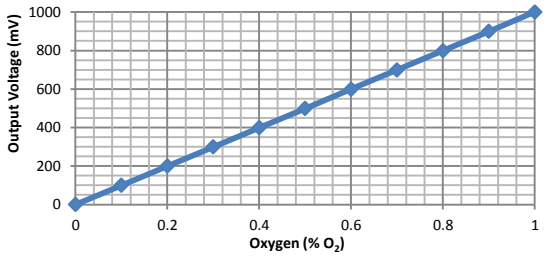
FCX-MQ-F-AC **Output (mV) = -99.5 x 1000 x Ln** $\left(1 - \frac{\%\ O_2}{100}\right)$ $\longleftrightarrow$ **% O2 = (1 - exp** $\left(\frac{\text{Output (mV)}}{-99.5 \times 1000}\right)$ **) x 100**

Example: 0.7 6 % O_2 = 759.1 mV

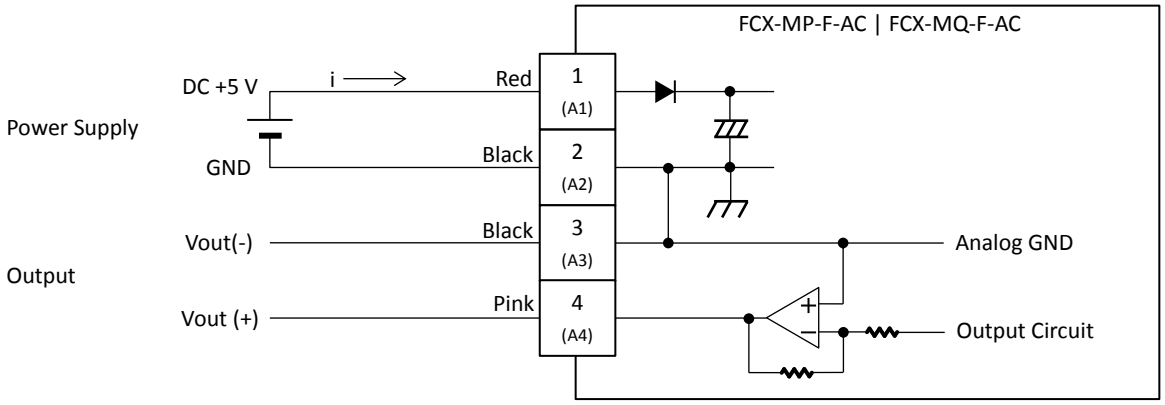
Simplified Chart for Output:

Unit: mV

The first decimal place \ The second decimal place	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	(0)	(10.0)	(19.9)	(29.9)	(39.8)	49.8	59.7	69.7	79.6	89.6
0.1	99.5	109.5	119.5	129.4	139.4	149.4	159.3	169.3	179.3	189.2
0.2	199.2	209.2	219.1	229.1	239.1	249.1	259.0	269.0	279.0	289.0
0.3	298.9	308.9	318.9	328.9	338.9	348.9	358.8	368.8	378.8	388.8
0.4	398.8	408.8	418.8	428.8	438.8	448.8	458.8	468.8	478.7	488.7
0.5	498.7	508.7	518.7	528.8	538.8	548.8	558.8	568.8	578.8	588.8
0.6	598.8	608.8	618.8	628.8	638.8	648.9	658.9	668.9	678.9	688.9
0.7	698.9	709.0	719.0	729.0	739.0	749.1	759.1	769.1	779.1	789.2
0.8	799.2	809.2	819.3	829.3	839.3	849.4	859.4	869.4	879.5	889.5
0.9	899.6	909.6	919.6	929.7	939.7	949.8	959.8	969.9	979.9	990.0
1.0	1000.0	–	–	–	–	–	–	–	–	–



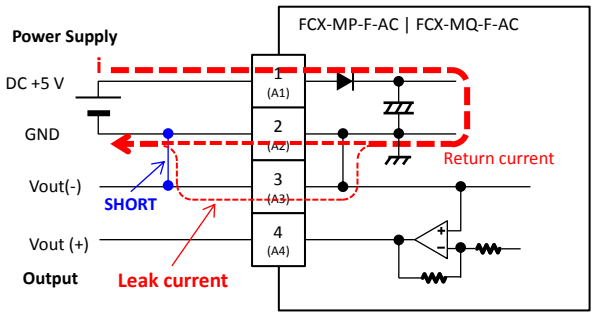
7 Wiring Connection and Interface



Notes:

*1) Do NOT short between GND of Power Supply and Vout(-) of Output with external wirings. It makes zero-shift of Output because the leak current flowed through the line of Vout(-).

*2) Please take care "unintentional short" between GND of Power Supply and Vout(-) with external wirings, when connecting a measurement device and a power source to the module. It would be recommended to check the electrical isolation between GND of Power Supply and Vout(-) of Output in the whole system.



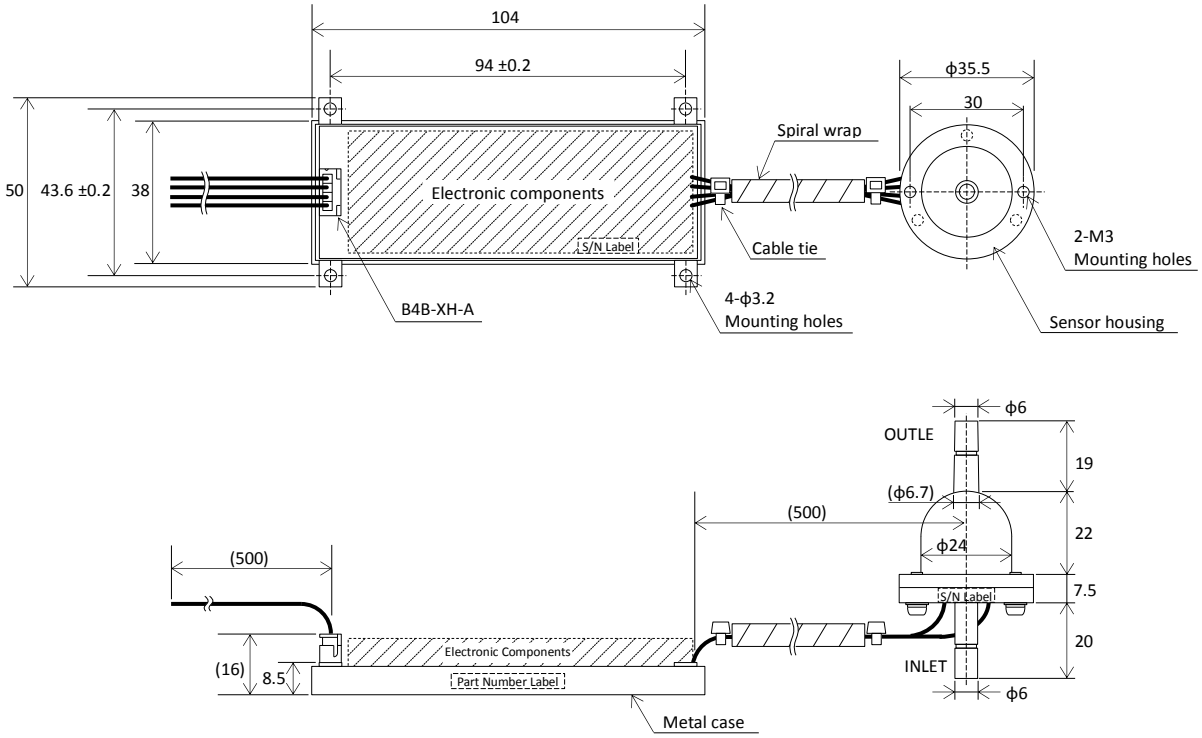
8 Calibration, Maintenance and Others

- The module including the oxygen sensor element is full-calibrated at the factory. User calibration is not required in the lifetime and user can NOT calibrate the module.
- Do NOT touch trimmers on the PC board. If setting of trimmers is changed, it is subject to damage the module.
- The module reaches the end of lifetime when the output does not meet the accuracy in the specifications.
- The module at the end of lifetime should replace a new module including an oxygen sensor. Fujikura does not provide services to replace and supply an oxygen sensor element only.
- For regular maintenance of the module, it would be recommended to check the output applying standard gases (N_2/O_2 mixture gases) to the oxygen sensor.
- Test report is attached to the module.
- Calibration certificate is available for a fee upon request.

9 Dimensions and Weights

Weight: Approx. 95 grams

Unit: mm



Note:

*1) Please make a distance above the electronic components on the PCB for natural air cooling.

*2) Do NOT touch the trimmers on the PCB.

10 Caution

Please carefully read the followings before using the oxygen sensor products.

Applications for medical appliances, life-support equipment and low oxygen detectors

*1) Fujikura products are not designed, intended or approved for use as components of surgical or life support systems, or other applications that may cause injury or death as a result of failure. In unapproved applications or uses where the customer implies, directly or indirectly, resultant injuries or deaths are due to Fujikura, Fujikura affiliates and agencies (citing for example, a design or manufacture fault), Fujikura, Fujikura affiliates and agencies shall be free from responsibility relating to any claims, costs, losses, and compensation.

*2) When a Fujikura product is to be used in medical appliances and oxygen detectors other than those mentioned above, it is strongly advised that fail-safe designs are established. Fujikura should be consulted for the necessary information.

Service life and guarantee period

*1) The end of service life shall be defined as the time when the output no longer meets the specified precision.

*2) The guarantee period is for one year from the date of shipment. During the guarantee period, should defects occur under normal conditions of use as specified in the manual and within the service life, the product will be repaired or replaced without charge. However, a repair or replacement fee will be charged in the following cases.

- Defect or damage due to inappropriate transportation or handling after delivery.
- Defect or damage caused by misuse, abuse or careless handling.
- Defect or damage due to unauthorized repairs or changes in configuration
- Damage to the cosmetic appearance caused during use
- Damage from fire, earthquake, flood or other natural disasters and abnormal voltage.

Operational precautions

Measurement of atmospheric gases:

Calibration gas	The sensor should be adjusted with a calibration gas that is a mixture of nitrogen, N_2 (or Argon, Ar) and oxygen, O_2. Other balance gases may result in incorrect measurements.
Combustible gases	An atmosphere continuing combustible gases such as methane, alcohol, hydrogen and carbon monoxide may cause errors in measurement. Since the sensor element functions at 450°C, gases that ignite below that temperature must not be used.
Silicon gases	Never use silicon gases containing siloxane, as these gases react with the sensor and produce oxides, destroying the performance of the sensor over a very short period.
Fluorocarbons	Do not use freons and others that contain halogens (F, Cl and Br), as these gasses react with materials inside the sensor and damage the performance.
Sulfur oxides and hydrogen	Never use sulfur oxides (SOx) and hydrogen (H_2), as they react with the sensor and destroy the performance of the sensor over a very short period.

Operating conditions:

Dust and oil mist	Employ a filter system to eliminate dust and oil mists that clog the sensor and analyzer filter, resulting in problems, measurement errors and incorrect responses.
Water and condensation moisture	Contact of the sensor with water may destroy the sensor. Exclude water from the system.
Others	・ Do not touch the sensor mesh while in operation, since the sensor mesh is heated to 50 to 80°C. ・ Do not subject the sensor to a shock of 10G or greater which may cause breaks in the wiring and cracks in the sensor chip. ・ The sensor element is made of a ceramic material. Never expose it to heat suddenly as this could destroy the element.

Others

Any product described in the catalogues may be altered without prior notice to improve reliability, function or design. Fujikura is not responsible for any incidents due to application of products and circuits described in the catalogues. No Fujikura patents or rights are licensed to a third party.